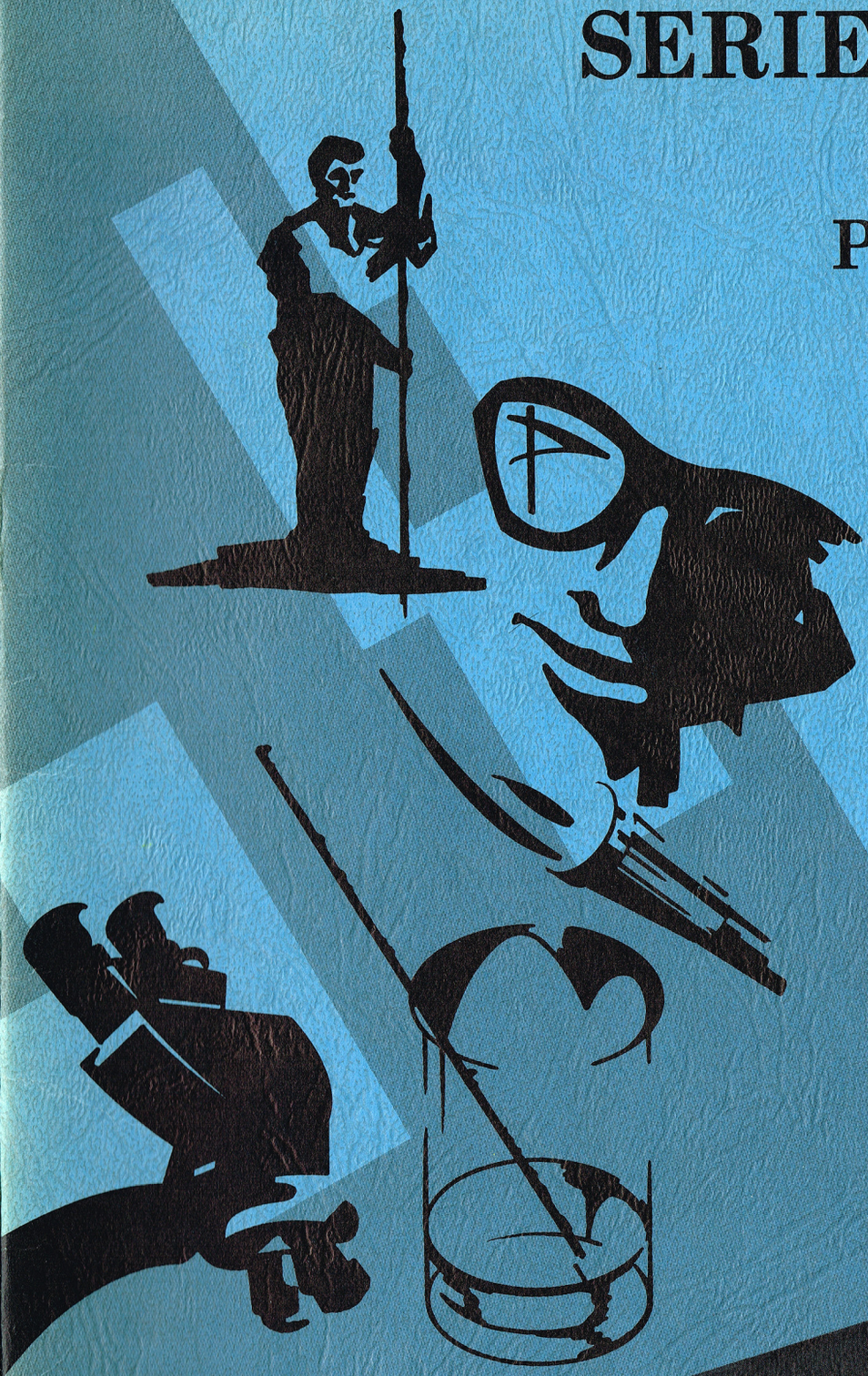
SERIES 700C/720C

ELECTRONIC PROGRAMMABLE CALCULATORS



REFERENCE MANUAL

WANG

SERIES 700C/720C

ELECTRONIC PROGRAMMABLE CALCULATORS

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PREFACE

Wang Laboratories, America's leading manufacturer of electronic calculating systems, would like to take this opportunity to thank you for your purchase of Wang calculating equipment.

As a company we are committed to a total program of services to meet the needs of our customers. We maintain an extensive library of programs and technical services. Our worldwide service organization complemented by trained personnel assures downtime to be at a minimum if at all.

This manual provides operating instructions for the Wang 700C/720C Series calculators. Illustrations are typical and show the principal design features of the units.

These instructions have been prepared as a service to our customers and are offered as suggested methods for the customers to follow so that the equipment may be installed, operated and maintained properly.

Wang Laboratories is dedicated to manufacturing the finest calculating equipment in the world. We are ready to serve you in any way that will best meet your requirements.

For further information, contact your local sales office or Wang Laboratories, Inc. 836 North Street, Tewksbury, Massachusetts 01876.

The 700A/B or the 720A/B Series Calculator manual should be studied thoroughly before proceeding with the study of this manual.

POWER REQUIREMENTS

115 or 230 VAC ± 10%
50 or 60 Hz

OPERATING ENVIRONMENT:

The normal environmental temperature required for proper operation of the Wang Model 700 is 25° Centigrade (77° Fahrenheit) ± 10° Centigrade (59° Fahrenheit to 95° Fahrenheit). If required, the 20° Centigrade operating range for Wang equipment can be adjusted for a minimum temperature of 10° Centigrade (50° Fahrenheit) or to a maximum of 40° Centigrade (104° Fahrenheit).

The recommended relative humidity range is from 20% to 80%.

DIMENSIONS:

9 inches high
20 inches wide
20½ inches deep

WEIGHT: Net 39 lbs. Gross 63 lbs.

MODEL	STEPS	STORAGE
700C	960	120
720C	1984	248

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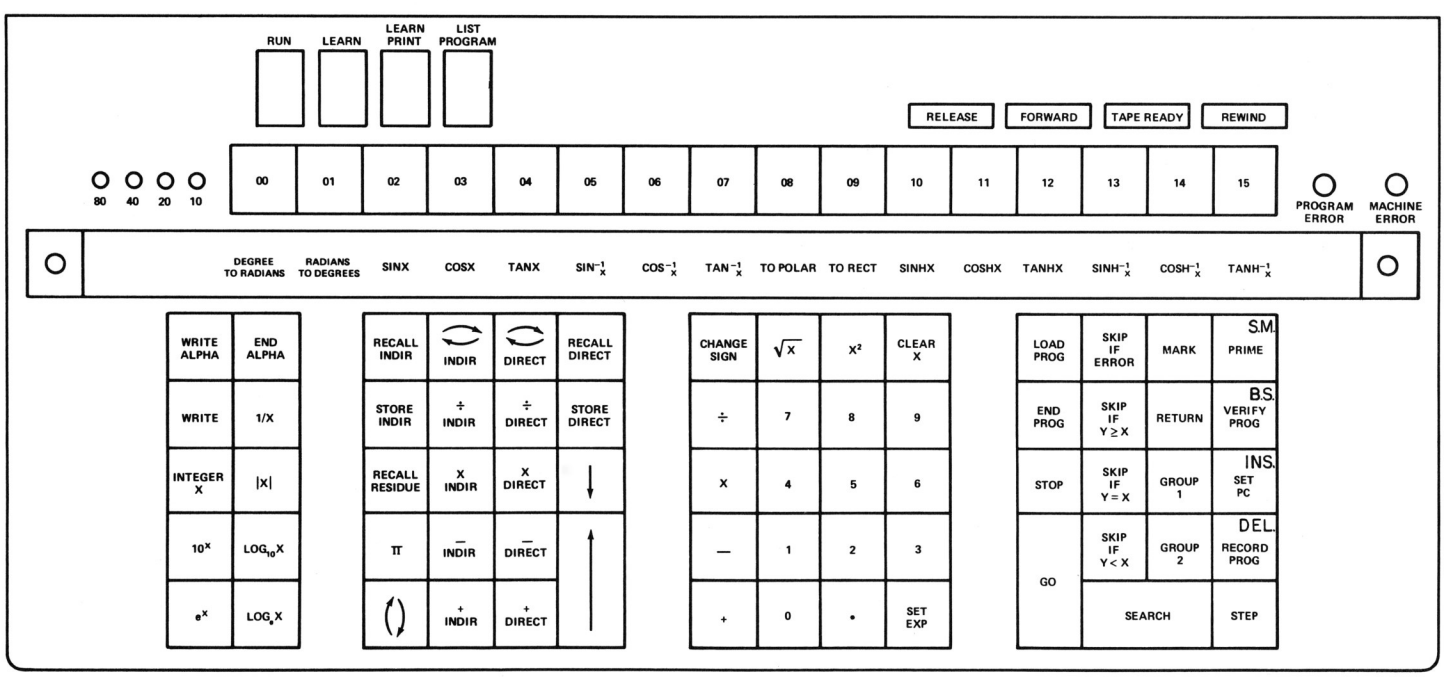
INTRODUCTION

Wang's new 700C/720C Electronic Programmable Calculators add a new dimension to the calculating power of those users who require on-site, fingertip control of sophisticated calculating applications. The flexibility of configurations made possible by a wide range of peripherals and choice of external memory devices guarantees a system that will meet your present requirements and, at the same time, be capable of expanding to meet your future requirements. The "C" models contain all the features of the 700B Model or 720B Model and, in addition, contain several new commands which facilitate the efficient handling of external storage devices, new program debugging commands and two new decision commands. Both the 700C and 720C retain the high performance characteristics of the 700 Series calculator line.



NEW DEBUGGING FEATURES

(Added to the 700/720 "C" Series Calculators)

BACKSTEP:

This operation allows the user to decrement the program counter. It is an excellent feature when writing or debugging a program. To operate this feature, the user must depress the RUN and LEARN switches simultaneously so that they are locked in their appropriate (down) positions. At this point, the display is in the position of LEARN MODE. To BACKSTEP, simply depress VERIFY PROGRAM. The program counter will decrease by one step with each key depression.

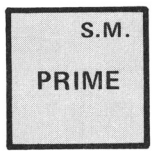
INSERT:

This feature allows the user to insert one or more steps at any point in the program. All steps following the insertion will automatically be shifted to make room for the additional step(s).

The RUN and LEARN switches MUST be depressed simultaneously. To insert a step into a program, set the P.C. to the step where you wish to insert the new instruction. (This should be done prior to engaging the RUN and LEARN switches.) Depress SET P.C. At this point, a GO command has been inserted (05 14) and the user may insert whatever step he needs to complete his program. **An END PROGRAM command must be present at the end of the program that is being corrected or revised.**

DELETE:

This command works in reverse of the INSERT command. **An END PROGRAM command must be present at the end of the program that is being corrected or revised.**



SEARCH, MARK and STOP:

This is one of the more useful commands available. Its two prime advantages are that it allows the user to see if he has already used a particular mark in his program, thereby preventing time-consuming errors. The second advantage is that it allows the user to search any mark in the program, and stop WITHOUT executing. This is particularly useful where many marks have been used and rather than step through a series of program steps, he can go directly to that mark.

The following pages will describe in detail the operational use of these features.

CAUTION:

Caution should be taken when the RUN and LEARN mode switches are engaged simultaneously. The keys PRIME, VERIFY PROGRAM, SET PC, and RECORD PROGRAM lose their normal functions and acquire new ones. These new functions: BACKSTEP, INSERT, DELETE, and SEARCH MARK and STOP are the added new features of the 700C line of calculators. **Remember:** *these keys change the function only when the RUN and LEARN mode switches are engaged simultaneously.*

TWO ADDITIONAL DECISIONS:

On the 700C Series, two additional decisions have been added to further increase programming capability. The 08 07 decision command will instruct the calculator to skip two steps if the X- and Y-Registers are alpha/numerically equivalent. This differs from the command SKIP if Y = X, since the latter implies decimal equivalence only. With the 08 07 command, you have the ability to compare program steps. The 08 15 decision command will instruct the calculator to skip two steps if the Y- and X-Registers are not alpha/numerically equivalent.

NOTE:

It is possible on the 700 to place in the display illegal characters which cause the display to blur. Up to now this has been meaningless to the calculator. It is now possible to test and use this function with the aid of two new compare commands which will test for any display characters, whereas the normal skip command must have valid numeric digits.

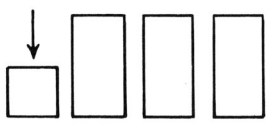
ADDRESSING THE NEW DEBUGGING FEATURES

The new debugging features in the 700 are intended to provide the user with an effective set of tools for maintaining a program. Features include a SEARCH MARK and STOP (S.M.), and a BACKSTEP (B.S.) key which, together with the STEP key, allow the programmer to step back and forth within a program. Other new features are the DELETE STEP (DEL) and INSERT STEP (INS). These functions allow the programmer to easily rearrange, add, or take out program steps anywhere in a program.

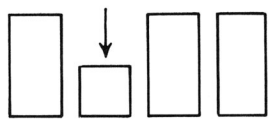
NOTE:

To use most of the keys on the 700, either the RUN Mode or LEARN Mode switch is depressed. The features described in this section however make use of a new mode, called the RUN/LEARN Mode. To put the 700 in the RUN/LEARN Mode, just depress both the RUN and LEARN switches simultaneously.

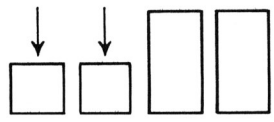
700 in RUN Mode



700 in LEARN Mode



700 in RUN/LEARN Mode



NOTE:

In the RUN/LEARN mode if any other keys are depressed they will be learned in the Learn Mode.

Any time you use the INSERT or DELETE features, be sure there is an END PROG. Step in the Program Memory; otherwise, the Program Error Indicator lamp will light and the display will flash.

PROGRAM DEBUGGING FEATURES OF THE "C" SERIES

THE SEARCH MARK and STOP – S.M. KEY

Because you are familiar with the operation of the 700, you already know that you can go directly to a routine within a program, and the machine will automatically execute the commands associated with that routine. To do this all that is necessary is to key SEARCH, and then key the number corresponding to the MARK you are searching for. However, during some debugging procedures, you may want to locate a MARK in a program and then stop before executing. You can do this easily on the 700 by using the RUN/LEARN mode, the S.M. key, and the 700 keyboard.

Example 1

The following diagram shows a MARK within a program:

	0193	0700	1
	0194	0702	2
	0195	0408	MARK
Display after	0196	0704	4
SEARCH MARK →	0197	0404	ST. DIR.
operation	0198	0609	π

If we want to SEARCH for this MARK and STOP before executing the commands, we can do the following:

1. Depress both the RUN and LEARN mode switches.
2. Key S.M. (the PRIME key).
3. Key 4

Result: The window will then show the first program command after the MARK 4 command.

0195	0408
0196	0704
0197	0404

As you can see, this two-step SEARCH, MARK and STOP function is very useful in long programs, or when we must search for a MARK in a program, but do not know its step number. This could result from several things, such as INSERT step or DELETE step, as described in the following sections. Either of these could change the step number associated with the program MARK.

THE BACKSTEP FEATURE – USING THE B.S. KEY

Example 2

Suppose we were examining a program and found ourselves in the following situation: The screen shows program step 0155, but we want to see step 0154. We could press SET P.C. and then key in the 0154, or we could do the following:

a. Depress both the RUN and LEARN mode switches.
b. Depress the B.S. (BACKSTEP) key.

Result: Program Step 0153 will appear in the window.

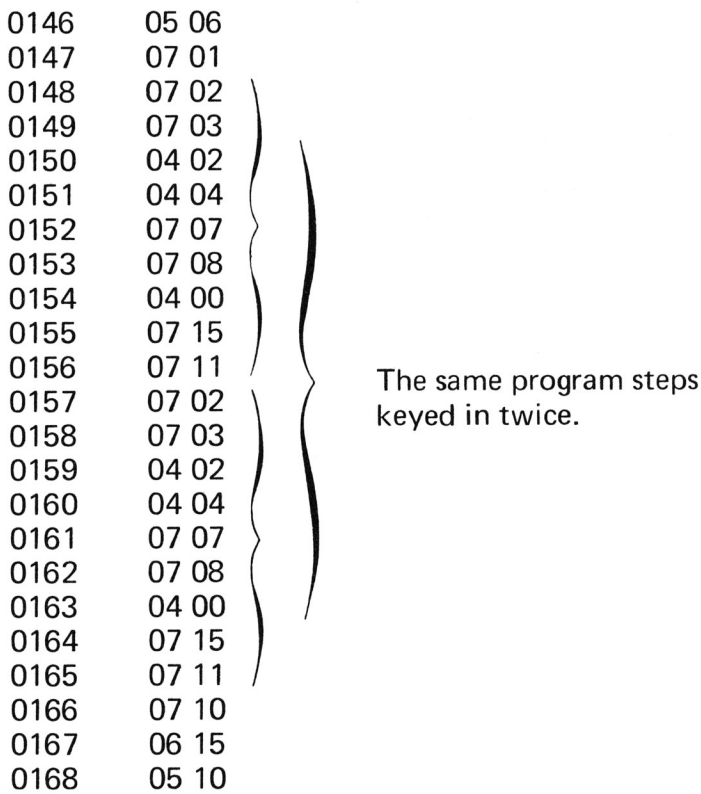
We could BACKSTEP all the way to Step 0000 if necessary. All we would have to do is press the B.S. key again and again until we reach 0000.

USING THE DEL KEY TO DELETE STEPS IN YOUR PROGRAM

One of the biggest headaches for a programmer is debugging or checking the program he has worked so hard to write. Not only must be often rearrange entire sections of his program, taking a section out here and putting it back there, but he must delete and insert individual steps as well. Depending on the complexity and length of the program, this can be a major task -- on any machine except the WANG 700, that is. Let us consider the DELETION function.

Example 3

John Brown has just entered the first part of his lengthy and complex program, and after standing back and admiring his work, notices he has entered a 7-step subroutine not once, but twice.
A listing would show the following:



Fortunately, J.B. realized he had one too many subroutines. To correct this situation J.B. determined that a DELETE STEP procedure would be the more efficient method. He proceeded to correct the problem in the following manner.

First he keyed SET P.C. and 0157.
The contents of the display:

0157 07 03

That is, program command (07 02) vanished from the program, and command (07 03) took its place as step 0157.

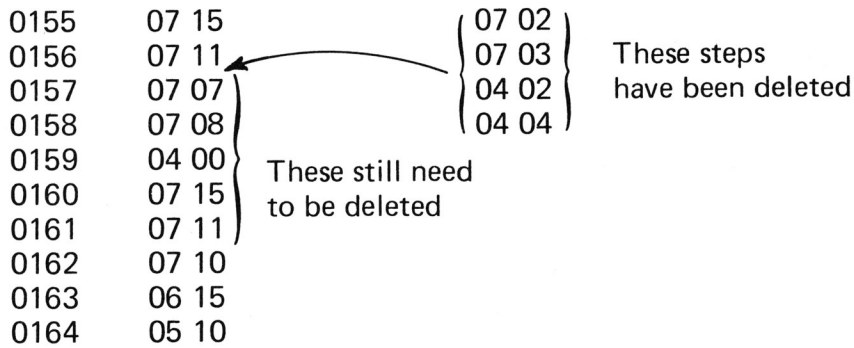
A listing of the program confirmed his suspicions.

BEFORE		AFTER	
0154	04 00	0154	04 00
0155	07 15	0155	07 15
0156	07 11	0156	07 11
0157	07 02	0157	07 03
0158	07 03	0158	04 02
0159	04 02	0159	04 04
0160	04 04	0160	07 07
0161	07 07	0161	07 08
0162	07 08	0162	04 00
0163	04 00	0163	07 15
0164	07 15	0164	07 11
0165	07 11	0165	07 10
0166	07 10	0166	06 15
0167	06 15		

At this point, not only had the program command been deleted, but all the following program steps moved up one place in line as well — repacking the program into the smallest available number of spaces.

Figuring that he could continue to DELETE steps by the above process, he keyed DEL (with both the RUN and LEARN mode switches still depressed) three more times.

A listing of a section of the program revealed the following:



After keying DEL five more times, with both the RUN and LEARN mode switches still depressed, J.B. found he had completely eliminated the unwanted subroutine.

You will find it just as easy to eliminate unwanted steps in your programs.

USING THE INS KEY TO INSERT STEPS IN YOUR 700 PROGRAM

Now that we can jump to any MARK in a 700 program (using the SEARCH, MARK and STOP function), move forward and backward within the program (using the STEP and B.S. features respectively), and DELETE any unwanted steps at will (using the DEL feature). There is only one non-programmable function left to complete our debugging package -- the INSERT step feature. By giving the programmer the ability to add program steps anywhere in the program easily, this function will prove to be one of the more powerful debugging features on the 700.

Example 4

Study the following:

To be inserted		
0713	0200	04 08
0500	0201	07 05
0503	0202	06 09
	0203	06 11
	0204	06 13

Note that we wish to INSERT three steps between program step 0202 and step 0203. To do this, we must first make room for the new steps, and then key in the new steps.

A. INSERTING SPACE INTO THE PROGRAM

1. SET P.C. to program step number 0203.
   The window would display

   0203 06 11

2. With the RUN and LEARN mode switches depressed, key INS (SET P.C.) once.
   The window would then display

   0203 05 14 (i.e., the GO command)

A listing of the program section would look like this

0200	04 08	
0201	07 05	
0202	06 09	
0203	05 14	→ GO
0204	06 11	
0205	06 13	

In other words, what we did was INSERT a GO command after step 0202, and then moved all the remaining program steps one step back; in effect, making room for the new step.

We now have successfully allowed space for the insertion of one of our three commands. We need two more spaces to INSERT the remaining steps into memory. Therefore, (with the RUN and LEARN mode switches still depressed), we key INS (SET P.C.) two more times.

Since the window still displays

0203 05 14

what do you think happened to the two inserted GO commands which occupied step 0203? They were moved back as well, one step each time the INS key was depressed, just like all the rest of the steps:

0200	04 08	
0201	07 05	
0202	06 09	
0203	05 14	GO
0204	05 14	
0205	05 14	
0206	06 11	
0205	06 13	

Now we are ready to key in our new commands.

B. INSERTING THE NEW STEPS IN THE PROVIDED SPACE

1. Backstep to the first inserted GO command. (If you are not there already.)
2. Key in the new steps over the GO commands, thus replacing them.

Result: Our insertion operation is complete.

The best way to assure yourself that you can INSERT extra steps when needed is to practice the technique right now. Just remember that before you INSERT a space into the program, the program step you want to follow your INSERT is displayed in the window. This will assure that the GO command "spacers" are inserted in the proper places.

The complete program update is shown below:

0200	04 08
0201	07 05
0203	06 09
0204	07 13
0205	05 00
0206	05 03
0207	06 11

Suggestion: If you must INSERT steps in a program in more than one location, you will find it easier to locate the proper places if you INSERT the last set of steps first. That is, if an INSERT is wanted between steps 7 and 8, and also between steps 35 and 36, make the latter INSERT first. Because an INSERT changes only the numbering of the steps which follow it, you will be sure of finding the location of the other steps easily.

NOTE:

As we have seen in the above discussion, keyboard controls of the 700 give the programmer the ability to easily alter a loaded program while the RUN and LEARN mode switches are both depressed. For this reason it is a good idea to take special care while debugging a program. The STEP and B.S. features will not alter a program by themselves. However, these keying operations could lead to the placing of program steps in the wrong places during an INSERT STEP procedure. In addition, the INSERT STEP (INS) and DELETE STEP (DEL) features could cause programming errors, if the keys are depressed at the wrong time. For this reason, it is a good idea to make a list of all changes to be made in a program and determine the new VERIFY CODE before altering the program itself. This way, you can check to see that you have made only the program changes you wanted to make, and no others.

Be sure that the steps you INSERT and/or DELETE do not change the logic of the program in ways you did not intend. For example, inserting or deleting a step directly after a SKIP IF Y=X (or any other skip command) will change the flow of the program and may cause the program to "hang-up". Similarly, the deletion of part of a MARK command may cause the machine to misinterpret the associated steps. In other words, be certain of your program changes before you make them – then you won't be surprised by the results.

EXAMPLE 1

SEARCH, MARK and STOP

TO LOCATE MARK 0802

1. RUN/LEARN MODE
2. Prime S.M.
3. 0802
4. Display will show 0605, the step following 0802.

TO LOCATE MARK 0801

1. RUN/LEARN MODE
2. Prime S.M.
3. 0801
4. Display will show 0405, the step following 0801.

EXAMPLE 2

BACKSTEP

TO BACKSTEP FROM MARK 0801

1. RUN/LEARN MODE
2. Verify (BS)
3. Display Step 017 code 0801
4. The program counter will decrease by one step with each depression of the (B.S.) key.

EXAMPLE 3

DELETE

TO DELETE A STEP FROM THE PROGRAM

1. Set P.C. 005 Display 0005 0404
2. RUN/LEARN MODE
3. Record Program (Del)
4. Display 005 0008

From program step 005 to the end of the program have all been moved down one step.

OPERATING PROCEDURES:

1. PRIME
2. LEARN MODE
3. Key in Program all steps (000-064) — also subroutine
4. RUN EXAMPLES 1, 2, and 3.

To run through these examples, the subroutine and main program are shown on the next page.

Subroutine of $f(x) = x^3 + 2x^2 + 3x^3 + 4$ for the main program.

000	04 08	MARK	016	06 02	x
001	03 00	03 00	017	06 06	↑↓
002	07 04	4	018	04 00	+ DIR
003	04 00	+ DIR	019	00 08	REG 008
004	00 08	REG 008	020	06 05	↓
005	04 15	RE Y	021	07 13	x^2
006	00 04	REG 004	022	06 02	x
007	07 03	3	023	06 05	↓
008	06 06	↑↓	024	04 00	+ DIR
009	00 02	x	025	00 08	REG 008
010	06 06	↑↓	026	07 00	0
011	04 00	+ DIR	027	04 06	EX DIR
012	00 08	REG 008	028	00 08	REG 008
013	07 02	2	029	05 11	RETURN
014	06 06	↑↓	030	05 12	END PROG
015	06 02	x			

MAIN PROGRAM

STEP	CODE	KEY	COMMENT	STEP	CODE	KEY	COMMENT
000	04 08	MARK	Simpson's	033	04 15	RE Y	
001	00 06	00 06	Rule	034	00 04	REG 004	
002	04 04	ST DIR	a	035	04 05	RE DIR	
003	00 04	REG 004		036	00 06	REG 006	
004	07 00	0		037	05 09	SKIP IF Y=X	
005	04 04	ST DIR		038	04 07	SEARCH	
006	00 08	REG 008		039	08 02	08 02	
007	05 15	STOP	x	040	03 00	SR 03 00	
008	04 04	ST DIR		041	04 00	+ DIR	
009	00 05	REG 005		042	00 07	REG 007	
010	05 15	STOP	b	043	04 15	RE Y	
011	04 04	ST DIR		044	00 05	REG 005	
012	00 06	REG 006		045	04 05	RE DIR	
013	03 00	SR 03 00		046	00 07	REG 007	
014	04 04	ST DIR		047	06 02	x	
015	00 07	REG 007		048	07 03	3	
016	04 08	MARK		049	06 03	÷	
017	08 01	08 01		050	07 15	CLEAR X	
018	04 05	RE DIR		051	05 15	STOP	
019	00 05	REG 005		052	04 08	MARK	
020	04 00	+ DIR		053	08 02	08 02	
021	00 04	REG 004		054	06 05	↓	
022	03 00	SR 03 00		055	03 00	SR 03 00	
023	06 04	↑		056	06 04	↑	
024	07 04	4		057	07 02	2	
025	06 02	x		058	06 02	x	
026	06 05	↓		059	06 05	↓	
027	04 00	+ DIR		060	04 00	+ DIR	
028	00 07	REG 007		061	00 07	REG 007	
029	04 05	RE DIR		062	04 07	SEARCH	
030	00 05	REG 005		063	08 01	08 01	
031	04 00	+ DIR		064	05 12	END PROG	
032	00 04	REG 004					

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